ANTI - FRICTION   LINESHAFT   BEARINGS

BY

A. S. ALTER

A. KATZINGER

ARMOUR   INSTITUTE   OF   TECHNOLOGY

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A STUDY OF

ANTI-FRICTION LINESHAFT BEARINGS

A THESIS

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ARTHUR KATZINGER
ARTHUR S. ALTER

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INTRODUCTION

The object of this test is the determination of the coefficient of friction and the horse power necessary to drive various types of line shafting bearings. Much research work has been done along these lines, but, no information is available which compares in a logical manner babbitt, roller and ball bearings.

In conducting these tests, the three types of bearings were operated at various loads and speeds varying from maximum to minimum. The power input was determined by means of a carefully calibrated reaction dynamometer and the coefficient of friction was calculated from the resulting data.

The bearings tested were: one ball, three roller and one babbitt. The method of procedure for one bearing was exactly the same for another. In each case the amount and kind of lubricant called for by the manufacturers of the bearings

was used. Before mounting a set of bearings
on the shaft each one was thoroughly cleaned
and the lubricant replaced.

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ARRANGEMENT OF APPARATUS

AND

METHOD OF TESTING

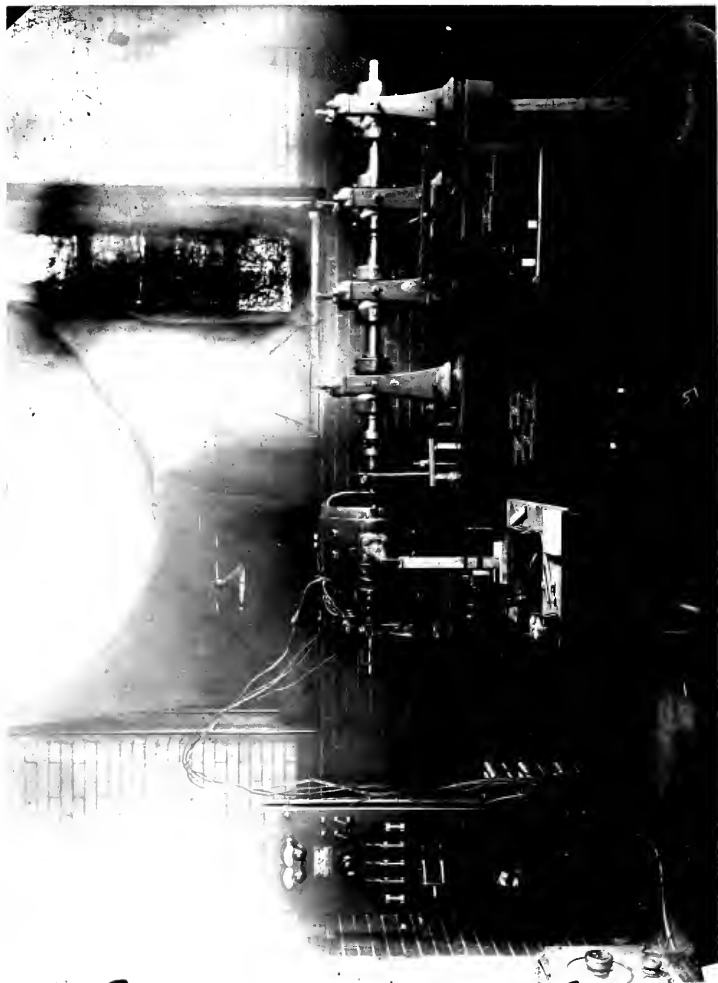- -

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Fig. 2

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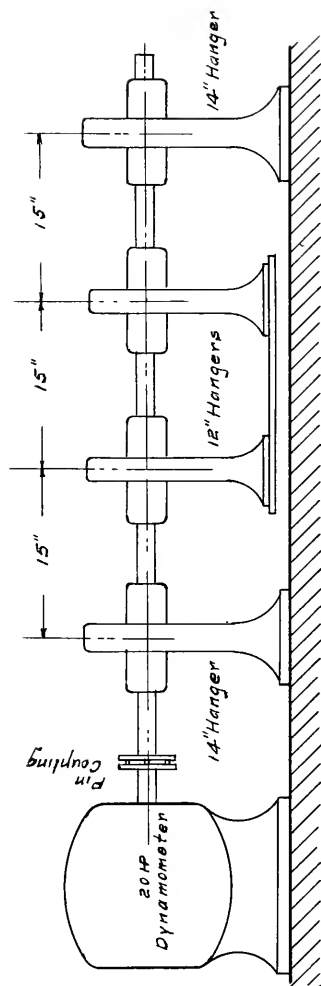
ARRANGEMENT OF APPARATUS AND
METHOD OF TESTING.

Two of the bearings were mounted in 14 inch hangers, and these hangers were bolted to a surfaced steel table and placed 45 inches from each other. The other two bearings were mounted in 12 inch hangers and spaced 15 inches center to center and midway between the first two hangers.(Fig.1)

A plate was bolted on the bottoms of the two middle hangers and served as a platform to receive the dead weight. The two central hangers were two inches shorter than the two outside hangers, thereby allowing the central unit to swing freely about the shaft.

The shaft was coupled to the 20 H.P. dynamometer. Two collars were placed on one of the center bearings and two on one of the end bearings to prevent end thrust travel.

All bearings were taken from the stock

intended for sale and were new. All sets
were operated until the friction became
constant. After these preliminary runs,
the apparatus was allowed to stand over
night so as to insure uniform temperature
conditions for each set of tests.

The load was placed in carriers
hung upon a stationary beam which rested
on the plate suppoted by the two center
hangers. The friction load was transmitted
through the agency of the dynamometer arm
to a sensitive scale.

The first load applied was 3000
pounds or 1500 pounds per bearing, and
the speed of the shaft was the maximum
which the bearing could stand. The speed
was obtained by an electric speed counter
and checked by a hand revolution counter.
The load on the scale was read at the same
time. The speed was then lowered a few
hundred R.P.M. and the load on scale again
read. This process was repeated until the
shaft was going as slowly as the motor

would turn it. Then the load was reduced from 3000 to 2700 and the entire process repeated; about twelve readings being taken for each load from 1500 down to 300 in increments of 150 pounds. The load of 300 was the minimum since this represented the actual weight of the hangers, bearings, shaft and plate.

This completed the run for a set of bearings, but, in order to verify the results the shaft and bearings were allowed to cool off until the next morning and the test repeated.

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GENERAL THEORY

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GENERAL THEORY

The load on the two center bearings
consisted of, the weights of the two center
bearings, the two center hangers, the cast
iron plate and the added dead weight. The
total load on the two end bearings was the
above weight plus the weight of the shaft
and coupling. The average load per bearing
was, therefore, one-half of the weight of
the two center bearings, the cast iron
plate, the shaft and coupling, and the
added weights. This is the load recorded
in the tables, and ranges from 1500 pounds
maximum to 300 pounds minimum.

All readings were taken simultaneously.
The dynamometer was tested for balance
before each new set of runs, thus insuring
accuracy.

The torque was obtained by multiplying
the force on the scale by the lever arm of
the dynamometer, in our case $31\frac{1}{2}$ inches.
This torque was in inch pounds, and repre-

sented the torque necessary to drive the
four bearings and one-fourth of this was
the torque necessary to drive one bearing.

The H. P. necessary to drive one
bearing at any load and speed, was
computed from the torque and speed by
accepted methods:

$$H.P. = \frac{Lbs. \ \& \ R.P.M.}{2000}$$

The 2000 is the constant of this
dynamometer.

The coefficient of friction was
computed from the load and the torque.
It is readily seen that the torque at
the shaft is equal to the ratio of the lever
arm of the dynamometer to the lever arm of
the shaft, the radius, times the torque at
the dynamometer arm, as follows:--

$$No. \ Lbs. \ torque \ x \ \frac{31.5"}{\frac{1-7"}{32}} = torque \ at \ shaft.$$

The coefficient of friction is the
torque at the shaft divided by the load.

$$Coefficient \ of \ friction = K. = \frac{torque \ at \ shaft}{load}$$

The coefficient of friction was computed
in two ways. In the first method, as out-
lined on page 12, designated in the tables
as "A", the actual radius of the shaft was
used. In the second method, the radius of
the ball or roller line circumference was
used.

It is a difficult matter to decide which
is the proper way to figure the coefficient.
It can be seen from the formula for the
coefficient of friction that the ball and
roller bearings assume a decided advantage
over the babbitt bearing by the use of
method "B", inasmuch as the friction radius is
increased by taking it as the distance from
center of ball or roller to the center of shaft,
and an increase in the friction radius decreases
the coefficient of friction.

In most of the testing done to date, the
coefficient of friction was usually figured
by method "B", but, it is the opinion of the
writers that it is unfair to the babbitt
bearings and for that reason, a preference

has been given to method "A". In a ball or
roller bearing, the friction really acts
at the tracks on which the balls or rolls
turn, but, for purposes of comparison with
plain bearings, the friction is referred
to the bearing bore, which is identical with
the shaft diameter.

It is understood that a comparison of
the coefficient of friction of bearings is
necessary, but, at the same time, it should
be understood that the coefficient of
friction influences, not so much the amount
of power to drive the shafting, as it influences
the bearing itself. A high coefficient will
shorten the life of the bearing, because a
great quantity of rubbing and lashing will
occur which will injure the bearing constituents.
This will be used up energy changed to the form
of heat, and it will ultimately cause an in-
crease in the power necessary to drive. But,
if an anti-friction bearing be properly de-
signed, there is little danger of an ex-
cessive coefficient of friction and the usual

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loss of power through heating.

For this reason, the truest comparison of bearings is to compare the horse power necessary to drive, and that the best bearing, is, the one which will run cold at any ordinary speed and load and require the least amount of power.

An important point in economic power transmission is lubrication. The manufacturers of babbitt bearings all recommend the use of machine oil, and in some instances, they have made tests to find out which oil was best suited to their bearing and how often and how much was required. But, when the anti-friction bearings came into use, the manufacturers maintained that ball and roller bearings should survive in the absence of lubrication, but, they now recommend the use of a lubricant, because, foreign matter in the raceways cannot be eliminated in any other way.

This does not necessarily mean that lubrication increases the efficiency of a

properly designed ball or roller bearing, for
the reverse is true, as has been illustrated
by experiments. They will give a lower
coefficient of friction when running clean
and dry than when lubricated by even a thin
oil.

In perfectly lubricated journal bearings,
there is no metallic contact between surfaces,
but, in the ball and roller bearings, there
is always metallic contact.

The coefficient of friction for sliding
contact is much higher than for rolling
contact. The coefficient of rest and slow
motion is much greater for sliding friction
than for rolling.

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CLASSIFICATION OF

BEARINGS TESTED

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CLASSIFICATION OF BEARINGS TESTED

For all convenience in this work,
each type of bearing tested is to be re-
ferred to by initial, as follows:--

BEARING

    "A".....DUPLEX TAPER ROLLER.

    "B".....HELICAL ROLLER.

    "C".....BABBITTED RING OILED.

    "D".....DOUBLE ROW SELF ALIGNING
             BALL BEARING.

    "E".....CYLINDRICAL PLAIN ROLLER.

BEARING "A"

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Fig. 3

Fig. 4

Fig. 5

BEARING "A"

Bearing "A" (Figures 3,4,5) is a
duplex roller bearing having as its chief
feature, two sets of double tapered rollers.
The housing of cast iron has a diameter
sufficient to contain one set of rolls
in each end.

A hardened steel cone fits on the
shaft and revolves with it. The double
tapered rolls run on this cone and are
held central by means of a projection in the
center of the cone which fits into the groove
of the rolls. (Fig.4) The rolls are kept
at a constant distance from each other by means
of a bronze separator.

On the top of the rolls are two tapered
cups arranged so that one is on the one taper
of the roll and one on the other. These two
tapered cups act as the upper raceway for the
rolls.

The whole set fits inside one end of
the housing, the end of which is threaded to
accomodate a nut which when screwed in tightens

or loosens the tapered cups against the rolls.
A set screw from the housing and onto the
adjustment is tightened when the bearing is
adjusted. Oil may be poured in through a
hole in the top of the housing.

Bearing "A" being of the double
taper type has in addition to the slipage
due to misalignment and the slipage due to
an area of contact instead of line contact,
the slipage due to the double taper. This
results from the fact that one laminae
of the roll is revolving at a slightly
greater or less speed than the next one
due to its greater or less diameter, thus
causing a slipage. But, the loss of power
or increase in coefficient due to this, is
negligible in comparison to the loss due to
misalignment and irregularity of surface.
For that reason, the firm manufacturing that
bearing claims that after the bearing has been
run in for two or three months, it runs at a
greater efficiency due to the polish of the
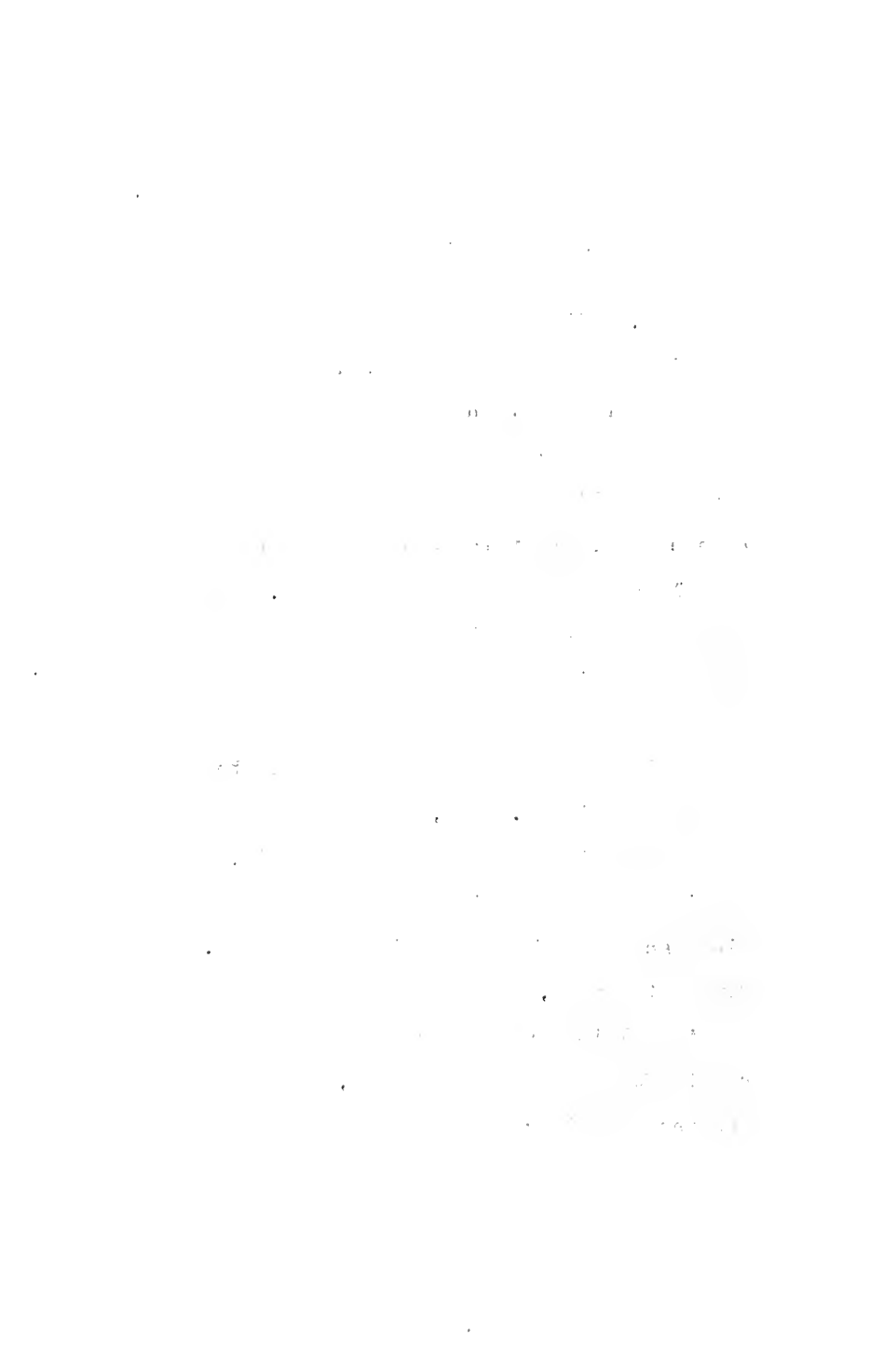
surfaces and grinding out of the rough spots
on the separator.

A good feature of Bearing "A", is,
that it showed very little tendency toward
the introduction of end thrust. The fact,
that the collars which go with this bearing
fit so that they revolve on the shaft and
at the same speed as the bearing sleeve,
eliminates any friction due to end thrust
which is a most desirable feature.

The bearing did not heat up to any extend,
except on such loads and speeds which very
seldom are used for line shafting work. As
can be seen by the data sheets and curves, this
bearing was run at higher speed than any of
the others. At the high speeds and loads,
the grease ran hot, but, as a whole, the bearing
ran remarkably cool.

Another good feature about this bearing
is, its adaptability to adjustment.

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TABLES 1 - 16

of

BEARING "A"

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BEARING A

Table No. _____ 1 _____ Date July 2nd, 1915.

Bearing Load, LBS. _____ 1500 _____ Time, beginning of run 8:20 A.M.

Room Temp.° Fahr. _____ 75 _____ Time, end of run 8:44 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at $31\frac{1}{2}$ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.55	1619	17.42	0.445	0.0095	0.0062
0.54	1513	17.00	0.408	0.0093	0.0061
0.535	1368	16.88	0.366	0.0092	0.0060
0.52	1148	16.40	0.298	0.0090	0.0058
0.505	876	15.91	0.219	0.0087	0.0056
0.52	806	16.40	0.208	0.0090	0.0058
0.525	679	16.57	0.178	0.0091	0.0059
0.535	611	16.88	0.163	0.0092	0.0060
0.55	501	17.42	0.138	0.0095	0.0062
0.57	372	17.98	0.106	0.0098	0.0064
0.62	212	19.56	0.066	0.0107	0.0069

Remarks:—

BEARING A

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.50	1743	15.75	0.436	0.0096	0.0062
0.485	1622	15.27	0.393	0.0093	0.0061
0.48	1446	15.11	0.347	0.0092	0.0060
0.47	1273	14.80	0.299	0.0090	0.0058
0.46	971	14.48	0.223	0.0088	0.0057
0.48	836	15.11	0.201	0.0092	0.0060
0.485	725	15.27	0.176	0.0093	0.0061
0.49	646	15.41	0.158	0.0094	0.0061
0.51	481	16.07	0.122	0.0098	0.0061
0.55	305	17.31	0.084	0.0105	0.0068
0.58	189	18.89	0.057	0.0115	0.0075

Remarks:—

BEARING A

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.46	1863	14.50	0.429	0.0099	0.0064
0.445	1714	14.02	0.382	0.0096	0.0062
0.425	1502	13.36	0.319	0.0091	0.0059
0.405	1216	12.75	0.246	0.0087	0.0056
0.40	1002	12.60	0.200	0.0086	0.0056
0.405	878	12.75	0.178	0.0087	0.0056
0.405	781	12.75	0.158	0.0087	0.0056
0.405	709	12.75	0.144	0.0087	0.0056
0.415	566	13.06	0.118	0.0089	0.0058
0.48	286	15.12	0.069	0.0103	0.0067
0.52	181	16.38	0.047	0.0112	0.0073

Remarks:—

B E A R I N G   A

Table No. _____4_____ Date__July 2nd,1915.____

Bearing Load, LBS. ___1050____ Time, beginning of run_9:23 A.M.

Room Temp.° Fahr. ___75____ Time, end of run_9:45 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.47	1956	14.78	0.460	0.0116	0.0075
0.43	1836	13.52	0.395	0.0106	0.0069
0.405	1715	12.75	0.347	0.0100	0.0065
0.39	1530	12.28	0.298	0.0096	0.0062
0.385	1241	12.10	0.239	0.0095	0.0062
0.325	919	11.80	0.172	0.0092	0.0060
0.365	810	11.48	0.148	0.0090	0.0058
0.365	688	11.48	0.126	0.0090	0.0058
0.375	510	11.80	0.096	0.0092	0.0060
0.425	269	13.38	0.057	0.0105	0.0068
0.475	170	14.92	0.046	0.0117	0.0076

Remarks:—

BEARING A

Table No. _____ 5 _____ Date July 2nd, 1915.

Bearing Load, LBS. _____ 900 _____ Time, beginning of run 9:45 A.M.

Room Temp.° Fahr. _____ 75 _____ Time, end of run 10:10 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.435	2065	13.70	0.453	0.0125	0.0081
0.39	1826	12.28	0.356	0.0112	0.0073
0.34	1687	10.70	0.287	0.0098	0.0064
0.33	1469	10.40	0.242	0.0095	0.0062
0.325	1279	10.23	0.208	0.0094	0.0061
0.32	948	10.08	0.152	0.0092	0.0060
0.32	841	10.08	0.135	0.0092	0.0060
0.315	715	9.93	0.113	0.0091	0.0059
0.32	490	10.08	0.079	0.0092	0.0060
0.37	242	10.64	0.045	0.0097	0.0063
0.40	166	12.60	0.033	0.0115	0.0075

Remarks:—

BEARING A

Table No. _____ 6 _____ Date_July 2nd,1915._

Bearing Load, LBS. _____ 750 _____ Time, beginning of run 10:10 A.M.

Room Temp.° Fahr. _____ 75 _____ Time, end of run 10:30 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.35	2205	11.02	0.386	0.0121	0.0079
0.325	2072	10.23	0.336	0.0112	0.0073
0.30	1834	9.46	0.275	0.0104	0.0067
0.28	1481	8.82	0.208	0.0097	0.0063
0.28	1308	8.82	0.183	0.0097	0.0063
0.27	1096	8.51	0.148	0.0093	0.0060
0.27	914	8.51	0.123	0.0093	0.0060
0.27	827	8.51	0.112	0.0093	0.0060
0.27	760	8.51	0.103	0.0093	0.0060
0.27	560	8.51	0.076	0.0093	0.0060
0.28	334	8.82	0.047	0.0097	0.0063
0.33	202	10.40	0.033	0.0114	0.0074

Remarks:—

Table No. _____ 7 _____ Date July 2nd, 1915. _____

Bearing Load, LBS. _____ 600 _____ Time, beginning of run 10:30 A.M.

Room Temp.° Fahr. _____ 75 _____ Time, end of run 10:45 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.33	2316	10.40	0.382	0.0142	0.0092
0.31	1944	9.78	0.302	0.0134	0.0087
0.28	1626	8.82	0.228	0.0121	0.0078
0.26	1329	8.19	0.173	0.0112	0.0073
0.25	1077	7.88	0.135	0.0108	0.0070
0.23	972	7.25	0.112	0.0099	0.0064
0.21	856	6.61	0.090	0.0091	0.0059
0.20	653	6.30	0.065	0.0086	0.0056
0.255	221	8.04	0.028	0.0110	0.0071
0.275	148	8.67	0.020	0.0119	0.0077

Remarks:—

BEARING A

Table No. _____ 8 _____   Date July 2nd,1915.

Bearing Load, LBS. _____ 450 _____   Time, beginning of run 10:45 A.M.

Room Temp.° Fahr. _____ 75 _____   Time, end of run _____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.29	2349	9.14	0.342	0.0167	0.0108
0.25	1986	7.88	0.248	0.0144	0.0093
0.23	1736	7.25	0.200	0.0132	0.0086
0.215	1439	6.78	0.155	0.0124	0.0080
0.20	1112	6.30	0.111	0.0115	0.0075
0.19	970	5.99	0.092	0.0109	0.0071
0.19	800	5.99	0.076	0.0109	0.0071
0.185	603	5.83	0.056	0.0106	0.0069
0.195	384	6.15	0.037	0.0112	0.0073
	206	10.08	0.033	0.0184	0.0119

Remarks:—
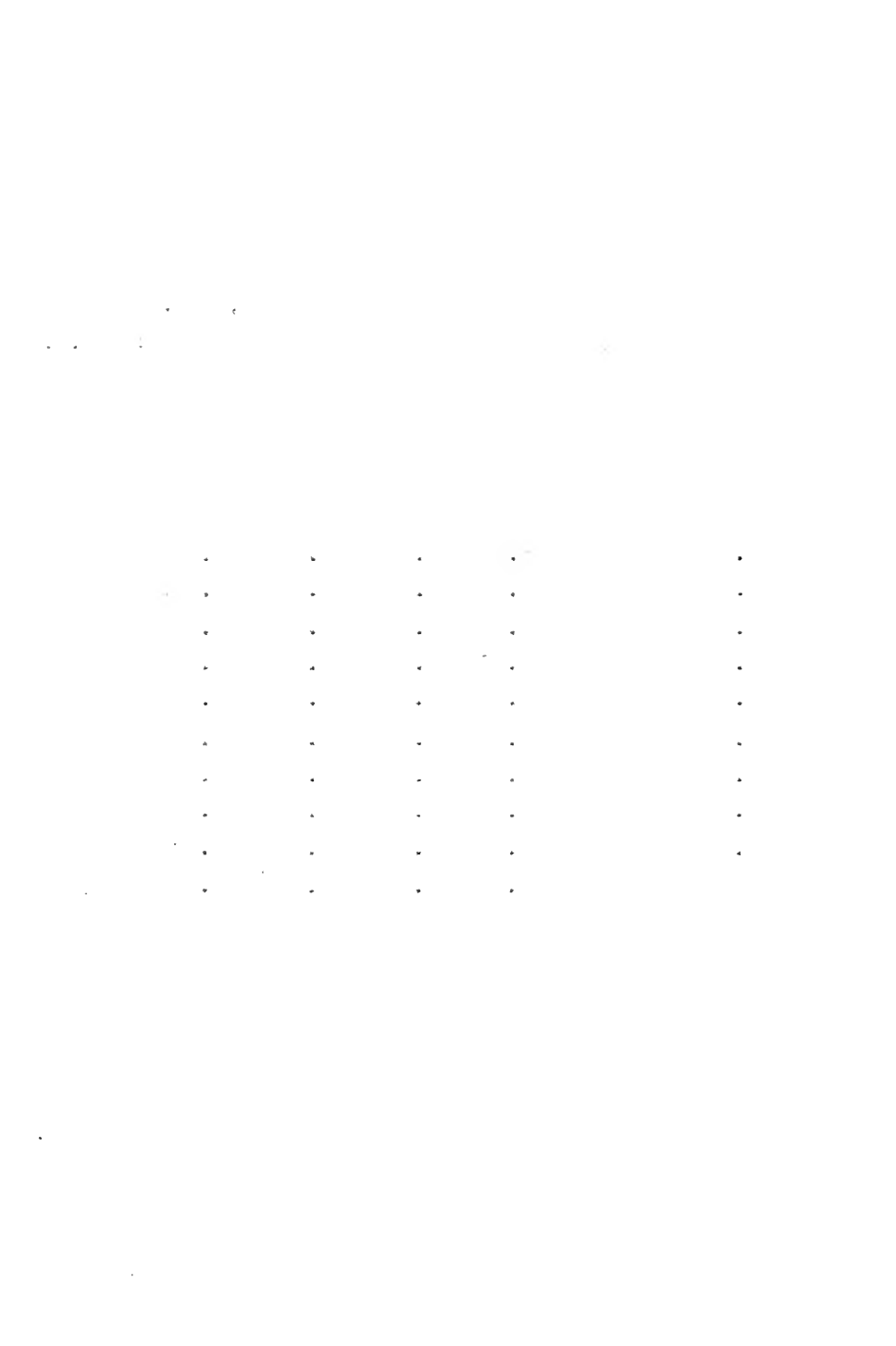
BEARING A

Table No. _____ 9 _____ Date July 2nd, 1915.

Bearing Load, LBS. _____ 300 _____ Time, beginning of run _____

Room Temp.° Fahr. _____ 75 _____ Time, end of run 11:15 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.22	2577	6.93	0.283	0.0189	0.0123
0.185	2174	5.83	0.201	0.0159	0.0103
0.165	1743	5.20	0.144	0.0142	0.0092
0.135	1388	4.25	0.094	0.0116	0.0075
0.105	988	3.31	0.052	0.0091	0.0059
0.09	886	2.83	0.040	0.0078	0.0051
0.085	818	2.68	0.035	0.0073	0.0047
0.08	591	2.52	0.024	0.0069	0.0045
0.105	235	3.31	0.012	0.0091	0.0059
0.13	139	4.09	0.009	0.0112	0.0073

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ A _____

R. P. M. of Shaft _____ 2000 _____

Table No. 10 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500			
1350			
1200			
1050			
900	0.400	0.012	0.0080
750	0.315	0.0115	0.0075
600	0.315	0.0130	0.0085
450	0.255	0.0150	0.0097
300	0.175	0.0150	0.0097

Remarks:—

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DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ A

R. P. M. of Shaft_____ 1600

Table No. 11

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.435	0.0095	0.0062
1350	0.390	0.0092	0.0060
1200	0.345	0.0095	0.0060
1050	0.316	0.0097	0.0062
900	0.265	0.010	0.0068
750	0.230	0.0105	0.0065
600	0.230	0.015	0.0075
450	0.180	0.0134	0.0085
300	0.125	0.0125	0.0080

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ A

R. P. M. of Shaft _____ 1200

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.315	0.0088	0.0055
1350	0.280	0.0090	0.0058
1200	0.245	0.0090	0.0058
1050	0.225	0.0095	0.0060
900	0.190	0.0093	0.0058
750	0.162	0.0096	0.0060
600	0.151	0.0098	0.0065
450	0.120	0.012	0.0070
300	0.070	0.0097	0.0060

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ A

R. P. M. of Shaft _____ 800

Table No. 13

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.21	0.0088	0.0055
1350	0.190	0.0095	0.0060
1200	0.165	0.0085	0.0055
1050	0.152	0.0092	0.0060
900	0.128	0.0090	0.0055
750	0.110	0.0092	0.0058
600	0.090	0.009	0.0059
450	0.075	0.0105	0.0065
300	0.038	0.0075	0.005

Remarks:—

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DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ A _____

R. P. M. of Shaft_____ 600 _____

Table No. _ 14 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.164	0.009	0.0064
1350	0.150	0.010	0.0068
1200	0.125	0.009	0.0055
1050	0.115	0.009	0.0060
900	0.10	0.009	0.0055
750	0.085	0.0092	0.0060
600	0.065	0.0090	0.0058
450	0.056	0.0107	0.0065
300	0.025	0.0071	0.0048

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ A _____

R. P. M. of Shaft _____ 400 _____

Table No. 15 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.115	0.0095	0.0063
1350	0.105	0.010	0.0068
1200	0.085	0.0098	0.0064
1050	0.080	0.0096	0.0063
900	0.068	0.0095	0.0060
750	0.057	0.0098	0.0063
600	0.045	0.0098	0.0060
450	0.042	0.013	0.0078
300	0.015	0.0077	0.0052

Remarks:—

40

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ A _____

R. P. M. of Shaft_____ 200 _____

Table No. 16 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.063	0.01	0.007
1350	0.062	0.011	0.0075
1200	0.045	0.011	0.0075
1050	0.042	0.0115	0.0075
900	0.038	0.0110	0.0073
750	0.035	0.0114	0.0075
600	0.025	0.0113	0.0070
450	0.032	0.0185	0.012
300	0.010	0.010	0.0065

Remarks:—

- -

CURVES PLOTTED FROM

TABLES 1 - 16

OF

BEARING "A"

- -

BEARING A TABLE NO. 67

BEARING LOAD

PERIPHERAL

2400

2000

1600

1200

800

400

R P M OF SHAFT

50

30

40

10

CONSUMPTION OF LUBRICANTS

45

HORSE POWER AT DRIVING

R. P. M. OF SHAFT

47

HORSE POWER vs. RPM's

BEARING. A BEARING No. B

BEARING LOAD

BROOM TEMP

R P M OF SHAFT

COEFFICIENT OF FRICTION

BEARING AT TABLE NO. 28
R.P.M. OF SHAFT 1500

FIGURE 41. TABLE NO. ...
F.O.M. OF SHAFT 42520

BEARING & TABLE No. 48
B.H.P. OF SHAFT ...

HORSE POWER PER DRIVE

CYLINDER TEMP. OR FRICTION

BEARING LOAD

58

- - - - - - - - - - - -- - - - - - - - - - - - - -

BEARING "B"

- -

Fig. 6

Fig. 7

Fig. 8

BEARING "B"

Bearing "B", (Figures 6,7,8), has as its
distinctive feature, a flexible roller which
is made from a strip of steel wound into a
helical coil or spring of uniform diameter.
There are eleven of the coiled rolls in each
bearing, six of them coiled in the right hand
direction and five in the left hand direction.
(Fig.7) The rolls are held in a separator
and they run directly on the shaft.

The box is of iron, cast in two parts
and lined with steel; the steel serving the
purpose of an outer raceway for the rolls.
(Fig.6)

The greatest advantage of a roller of
this construction is, that it is flexible,
which enables it to present a bearing surface
along its entire length resulting in a uniform
distribution of the load. The roller adjusts
itself to any irregularity in the rubbing
surface. The roller being hollow acts as an

oil reservoir, thereby, assuring good
lubrication at all times.

These bearings could not be run over
seven hundred revolutions, it being the
claim of the firm manufacturing this bearing
that it is built only for ordinary line
shaft purposes; in other words, at speeds
of 300 to 400 R.P.M.

At such speeds these bearings showed
a tendency to heat up, but, not to any
great extent on the lighter loads.

These rollers can be made longer than
a solid roller, because, they are flexible,
whereas, a solid roll does not bend to the
deflection of the shaft. But, there is a
disadvantage to this roller just as there is
to the solid ones. It requires power to
flex a spring, therefore, the constant
working of these resilient rolls to allow
for irregularities of alignment and surface
must absorb an appreciable amount of power
which is dissipated as heat.

- -

TABLES 1 - 13

OF

BEARING "B"

- -

BEARING B

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.68	745	21.40	0.253	0.0117	0.0089
0.65	653	20.48	0.212	0.0112	0.0085
0.62	632	19.52	0.196	0.0107	0.0081
0.595	617	18.72	0.184	0.0103	0.0078
0.58	603	18.26	0.175	0.0100	0.0076
0.54	559	17.00	0.151	0.0093	0.0071
0.525	456	16.51	0.120	0.0091	0.0069
0.495	443	15.58	0.110	0.0085	0.0064
0.45	390	14.16	0.088	0.0078	0.0059
0.42	328	13.23	0.069	0.0073	0.0055
0.39	283	12.28	0.055	0.0061	0.0051
0.305	224	11.50	0.041	0.0063	0.0048
0.35	178	11.00	0.031	0.0060	0.0046

Remarks:—

BEARING B

Table No. _____2_____ Date _July 6th,1915._

Bearing Load, LBS. _1350_ Time, beginning of run _10:30 A.M._

Room Temp.° Fahr. _72_ Time, end of run _11:10 A.M._

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.585	729	18.41	0.213	0.0112	0.0085
0.56	708	17.65	0.198	0.0107	0.0081
0.535	657	16.85	0.176	0.0102	0.0077
0.51	633	16.07	0.161	0.0098	0.0074
0.49	599	15.42	0.147	0.0094	0.0071
0.455	536	14.35	0.122	0.0087	0.0066
0.42	495	13.22	0.104	0.0080	0.0061
0.39	410	12.28	0.080	0.0075	0.0057
0.365	373	11.48	0.068	0.0070	0.0053
0.335	271	10.54	0.045	0.0064	0.0048
0.31	207	9.76	0.032	0.0059	0.0045
0.30	174	9.45	0.026	0.0057	0.0043

Remarks:—

BEARING B

Table No. _____3_____ Date July 6th, 1915.

Bearing Load, LBS. _____1200_____ Time, beginning of run 11:18 A.M.

Room Temp.° Fahr. _____72_____ Time, end of run 11:30 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.555	771	17.50	0.214	0.0120	0.0091
0.50	689	15.75	0.172	0.0108	0.0082
0.48	662	15.12	0.159	0.0103	0.0078
0.45	611	14.18	0.137	0.0094	0.0071
0.395	510	12.45	0.101	0.0085	0.0064
0.36	436	11.34	0.079	0.0078	0.0059
0.305	262	9.62	0.040	0.0066	0.0050
0.285	183	8.97	0.026	0.0061	0.0046

Remarks:—

BEARING B

Table No._____4_____ Date July 6th, 1915.

Bearing Load, LBS._____1050_____ Time, beginning of run 11:30 A.M.

Room Temp.° Fahr._____72_____ Time, end of run 11:46 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.495	758	15.57	0.188	0.0122	0.0092
0.45	674	14.18	0.152	0.0111	0.0084
0.425	628	13.38	0.133	0.0105	0.0079
0.40	589	12.58	0.118	0.0099	0.0075
0.37	524	11.64	0.097	0.0091	0.0069
0.315	400	9.92	0.063	0.0078	0.0059
0.28	285	8.82	0.040	0.0069	0.0052
0.25	196	7.87	0.025	0.0062	0.0047

Remarks:—

BEARING B

Table No. 5 Date July 6th, 1915.

Bearing Load, LBS. 900 Time, beginning of run 11:46 A.M.

Room Temp.° Fahr. 72 Time, end of run 11:56 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31¾ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.46	730	14.48	0.168	0.0132	0.0100
0.425	676	13.37	0.144	0.0122	0.0092
0.395	614	12.42	0.121	0.0113	0.0086
0.345	490	10.87	0.085	0.0099	0.0075
0.285	311	8.97	0.044	0.0082	0.0062
0.25	205	7.87	0.026	0.0072	0.0055
0.235	132	7.39	0.016	0.0067	0.0051

Remarks:—

BEARING B

Table No. ____6____ Date July 6th, 1915.

Bearing Load, LBS. ____750____ Time, beginning of run 11:56 A.M.

Room Temp.° Fahr. ____72____ Time, end of run 12:10 P.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.44	743	13.82	0.163	0.0151	0.0114
0.40	667	12.57	0.134	0.0138	0.0104
0.35	574	11.02	0.100	0.0121	0.0092
0.32	492	10.08	0.079	0.0110	0.0083
0.265	328	8.35	0.043	0.0091	0.0069
0.23	265	7.24	0.031	0.0079	0.0060
0.22	147	6.93	0.016	0.0076	0.0058

Remarks:—

BEARING B

Table No. ___7___ Date July 6th, 1915.

Bearing Load, LBS. ___600___ Time, beginning of run 12:10 P.M.

Room Temp.° Fahr. ___72___ Time, end of run 12:30 P.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.41	719	12.89	0.147	0.0176	0.0133
0.375	672	11.79	0.126	0.0161	0.0122
0.335	574	10.53	0.096	0.0144	0.0109
0.30	493	9.45	0.074	0.0129	0.0098
0.255	329	8.03	0.042	0.0110	0.0083
0.255	334	8.03	0.043	0.0110	0.0083
0.24	305	7.55	0.037	0.0103	0.0078
0.225	274	7.08	0.031	0.0097	0.0073
0.215	217	6.76	0.023	0.0093	0.0070
0.20	155	6.29	0.016	0.0086	0.0065

Remarks:—

BEARING B

Table No. _____8_____ Date ⌣July 6th, 1915.

Bearing Load, LBS. ___450___ Time, beginning of run 12:30 P.M.

Room Temp.° Fahr. ___72___ Time, end of run 12:45 P.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31⅓ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.40	730	12.60	0.146	0.0230	0.0174
0.36	663	11.35	0.119	0.0207	0.0157
0.33	597	10.40	0.098	0.0190	0.0144
0.29	504	9.13	0.073	0.0167	0.0126
0.25	342	7.88	0.042	0.0144	0.0109
0.205	240	6.46	0.025	0.0118	0.0089
0.19	164	5.98	0.016	0.0109	0.0082

Remarks:—

BEARING B

Table No. **9** Date **July 6th, 1915.**

Bearing Load, LBS. **300** Time, beginning of run **12:45 P.M.**

Room Temp.° Fahr. **72** Time, end of run **12:55 P.M.**

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.365	734	11.50	0.134	0.0316	0.0239
0.335	675	10.55	0.113	0.0289	0.0219
0.30	592	9.75	0.089	0.0259	0.0196
0.265	481	8.35	0.064	0.0229	0.0173
0.225	372	7.08	0.042	0.0194	0.0147
0.195	264	6.14	0.026	0.0168	0.0127
0.175	155	5.52	0.014	0.0151	0.0114

Remarks:—
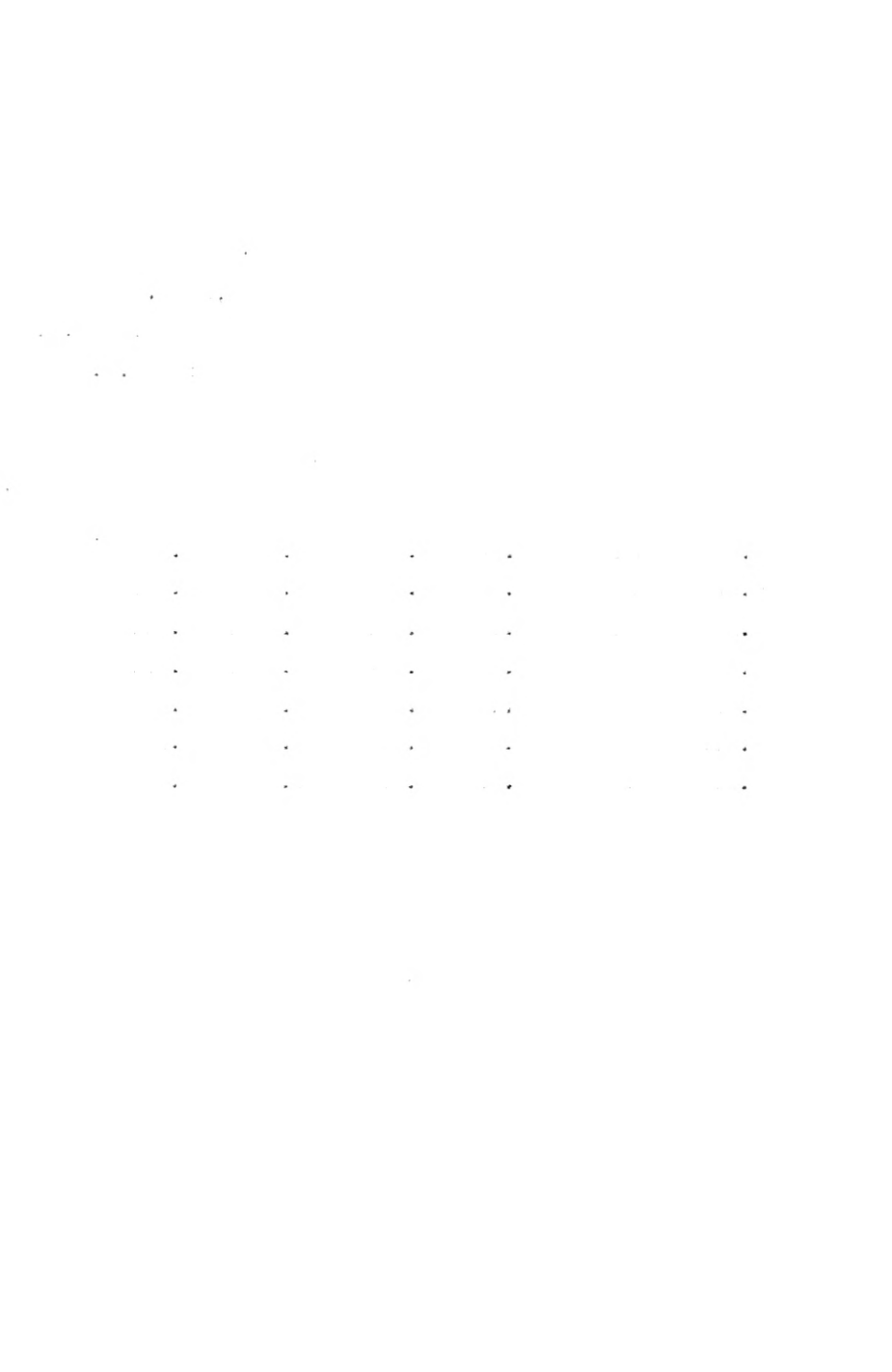
DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ B

R. P. M. of Shaft_____ 800

Table No.___ 10

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500		0.0120	0.0097
1350		0.0120	0.0097
1200	0.23	0.0120	0.0095
1050	0.223	0.0130	0.0098
900	0.210	0.0147	0.0115
750	0.195	0.0160	0.0125
600	0.195	0.0135	0.0140
450	0.185	0.025	0.0193
300	0.160	0.036	0.026

Remarks:—

74

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ B

R. P. M. of Shaft _____ 600

Table No. ___ 11

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.170	0.0100	0.0077
1350	0.14	0.0092	0.0072
1200	0.135	0.0092	0.0070
1050	0.120	0.010	0.0075
900	0.1150	0.0115	0.0085
750	0.110	0.0123	0.0095
600	0.105	0.0148	0.011
450	0.100	0.0190	0.0142
300	0.092	0.0262	0.020

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ B

R. P. M. of Shaft _____ 400

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.09	0.008	0.006
1350	0.065	0.0073	0.0055
1200	0.070	0.0075	0.0054
1050	0.063	0.0080	0.0055
900	0.057	0.0090	0.0065
750	0.055	0.0095	0.0075
600	0.052	0.0115	0.0065
450	0.048	0.0145	0.0108
300	0.045	0.020	0.0150

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ B _____

R. P. M. of Shaft_____ 200 _____

Table No. 13 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.042	0.0068	0.0050
1350	0.025	0.0060	0.0045
1200	0.032	0.0063	0.0045
1050	0.028	0.0065	0.0045
900	0.023	0.0075	0.0052
750	0.023	0.0080	0.0060
600	0.022	0.0095	0.0068
450	0.020	0.0117	0.0086
300	0.020	0.016	0.0120

Remarks:—

CURVES PLOTTED FROM

TABLES 1 - 13

OF

BEARING "B"

FIGURE 51 Bearing No. 5B.

- -

"BEARING "C"

- -

Fig. 9

Fig. 10

BEARING "C"

Bearing "C", (Figures 9,10), is the
ordinary type of ring oiled babbitt bearing.
The housing contains the oil which is carried
up from the reservoir to the top of the
shaft from whence it is distributed along
the whole bearing length. The bottom piece
of babbitt is detachable and fits into the
lower housing, while the top babbitt is
fixed into the upper housing. The babbitt
contained no oil grooves.

When this type of bearing is new, it
is very economical and its coefficient of
friction is low. The reason for this being
that the babbitt has high spots on which
the shaft runs and because the shaft runs
on the high spots, the oil is pressed into
the low spots at enormous pressures, thereby,
giving the shaft a pressure feed oil lubrication
which of necessity lowered the friction in the
bearings. After the completion of the tests

on this type of bearing it was found that
the bearings had only been worn on two or
three high spots.

The fact that in time the high spots
on the bearing will wear down so that the
shaft will run on the entire babbitt
surface does not mean that the friction will
be less. To the contrary, the more bearing
surface the shaft has, the less oil space it
has and the higher the friction will be.
In journal bearings, the better the lubrication,
the lower the friction.

At no time during the test were we able
to start the line shaft with any load on.
The bearings were all as loosely adjusted as
it was possible to make them, but, even so,
the 20 H.P. dynamometer would not turn over
the shaft when the load was on. This is
certainly a very objectionable feature of
this bearing. It shows that the starting
or slow moving sliding friction is a long
way out of proportion to that of rolling
friction.

- -

TABLES 1 - 16

OF

BEARING "C"

- -

BEARING C

Table No. _____1_____ Date _July 9th, 1915._

Bearing Load, LBS. _1500_ Time, beginning of run _8:50 A.M._

Room Temp.° Fahr. _69_ Time, end of run _9:20 A.M._

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.63	1474	19.85	0.465	0.0109	
0.555	1392	17.48	0.387	0.0096	
0.495	1187	15.58	0.294	0.0085	
0.46	979	14.48	0.225	0.0079	
0.445	888	14.02	0.198	0.0077	
0.425	845	13.38	0.180	0.0073	
0.43	807	12.75	0.164	0.0070	
0.385	750	12.11	0.144	0.0066	
0.375	688	11.80	0.129	0.0065	
0.365	598	11.50	0.109	0.0063	
0.335	497	10.55	0.083	0.0058	
0.34	382	10.70	0.065	0.0059	
0.34	317	10.70	0.053	0.0059	
0.345	302	10.85	0.052	0.0060	

Remarks:—

BEARING C

Table No._____2_____ Date__July 9th,1915.____

Bearing Load, LBS.____**1350**____ Time, beginning of run_9:20_A.M.

Room Temp.° Fahr.____69____ Time, end of run_9:42_A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.485	1508	15.28	0.366	0.0093	
0.44	1369	13.82	0.301	0.0084	
0.385	1043	12.11	0.201	0.0074	
0.365	914	11.47	0.167	0.0070	
0.355	845	11.17	0.150	0.0068	
0.34	763	10.38	0.126	0.0063	
0.32	688	10.07	0.110	0.0061	
0.305	538	9.61	0.082	0.0058	
0.30	382	9.45	0.057	0.0057	
0.30	290	9.45	0.044	0.0057	
0.315	262	9.93	0.041	0.0060	
0.32	240	10.07	0.038	0.0061	

Remarks:—

BEARING C

Table No. _____ 3 _____ Date __July 9th,1915.____
Bearing Load, LBS. ___ 1200 _____ Time, beginning of run 9:42 A.M.
Room Temp.° Fahr. _____ 69 _____ Time, end of run 9:58 A.M.
Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31⅓ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.465	1620	13.08	0.337	0.0090	
0.37	1386	11.64	0.257	0.0080	
0.32	1060	10.08	0.169	0.0069	
0.295	920	9.28	0.136	0.0064	
0.28	833	8.82	0.117	0.0061	
0.27	773	8.50	0.104	0.0058	
0.255	653	8.04	0.083	0.0055	
0.245	530	7.72	0.065	0.0053	
0.225	328	7.08	0.037	0.0049	
0.24	242	7.56	0.029	0.0052	

Remarks:—

BEARING C

Table No._____4_____   Date_July 9th,1915._____

Bearing Load, LBS.____1050____ Time, beginning of run_9:58 A.M.

Room Temp.° Fahr._____69_____ Time, end of run_10:15 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.39	1659	12.28	0.324	0.0096	
0.335	1498	10.56	0.251	0.0083	
0.29	1273	9.13	0.185	0.0071	
0.24	934	7.56	0.112	0.0059	
0.23	819	7.25	0.094	0.0057	
0.225	753	7.08	0.085	0.0055	
0.21	607	6.62	0.064	0.0052	
0.195	415	6.14	0.040	0.0048	
0.195	267	6.14	0.026	0.0048	
0.185	223	5.83	0.021	0.0046	

Remarks:—

100

BEARING C

Table No. _____5_____ Date _July 9th, 1915._

Bearing Load, LBS. ____900____ Time, beginning of run _10:15_ A.M.

Room Temp.° Fahr. ___69___ Time, end of run _10:30 A.M._

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.365	1618	11.50	0.295	0.0105	
0.32	1448	10.08	0.231	0.0092	
0.28	1258	8.82	0.176	0.0081	
0.245	1118	7.73	0.137	0.0072	
0.215	933	6.78	0.100	0.0062	
0.205	863	6.46	0.088	0.0059	
0.20	796	6.30	0.080	0.0058	
0.195	728	6.46	0.075	0.0059	
0.200	561	6.30	0.056	0.0058	
0.195	481	6.14	0.047	0.0056	
0.185	373	5.83	0.035	0.0053	
0.17	276	5.36	0.024	0.0049	
0.175	240	5.52	0.021	0.0050	

Remarks:—

BEARING C

Table No. ___6___   Date _July 9th,1915._

Bearing Load, LBS. _750_   Time, beginning of run **10:35** A.M.

Room Temp.° Fahr. _69_   Time, end of run _10:50 A.M._

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.355	1608	11.18	0.286	0.0122	
0.315	1472	9.92	0.232	0.0109	
0.285	1274	8.98	0.182	0.0098	
0.23	1073	7.25	0.123	0.0080	
0.215	958	6.78	0.103	0.0074	
0.20	885	6.30	0.089	0.0069	
0.19	807	5.98	0.077	0.0066	
0.185	724	5.83	0.067	0.0064	
0.175	548	5.51	0.048	0.0060	
0.165	424	5.20	0.035	0.0057	
0.155	343	4.88	0.027	0.0054	
0.155	300	4.88	0.023	0.0054	
0.15	230	4.72	0.017	0.0052	

Remarks:—

BEARING C

Table No. _____7_____ Date __July 9th,1915.__

Bearing Load, LBS. ___700___ Time, beginning of run __10:50 A.M.__

Room Temp.° Fahr. ___69___ Time, end of run __11:05 A.M.__

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.325	1664	10.21	0.271	0.0140	
0.29	1500	9.13	0.218	0.0125	
0.25	1323	7.88	0.166	0.0108	
0.22	1122	6.93	0.123	0.0095	
0.19	944	5.98	0.090	0.0082	
0.17	816	5.35	0.069	0.0073	
0.145	621	4.56	0.045	0.0063	
0.125	373	3.94	0.023	0.0054	
0.115	264	3.62	0.015	0.0050	
0.11	203	3.46	0.011	0.0047	

Remarks:—

BEARING C

Table No._____8_____   Date__July 9th,1915.__

Bearing Load, LBS.____450____   Time, beginning of run 11:05 A.M.

Room Temp.° Fahr.____69____   Time, end of run 11:21 A.M.

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.29	1660	9.13	0.241	0.0167	
0.27	1583	8.50	0.214	0.0155	
0.245	1463	7.72	0.179	0.0141	
0.225	1224	7.08	0.137	0.0129	
0.405	1177	6.46	0.121	0.0118	
0.175	967	5.51	0.085	0.0101	
0.155	860	4.88	0.067	0.0089	
0.145	760	4.57	0.055	0.0084	
0.12	525	3.78	0.032	0.0069	
0.12	411	3.78	0.025	0.0069	
0.10	230	3.15	0.012	0.0058	
0.08	168	2.52	0.007	0.0046	

Remarks:—

BEARING C

Table No. _____9_____ Date __July 9th,1915.__

Bearing Load, LBS.____300____ Time, beginning of run **11:21** A.M.

Room Temp.° Fahr.____69____ Time, end of run__11:38 A.M.__

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.25	1660	7.88	0.208	0.0216	
0.235	1611	7.40	0.189	0.0203	
0.22	1503	6.93	0.165	0.0190	
0.205	1248	6.46	0.128	0.0177	
0.17	1137	5.36	0.097	0.0147	
0.145	979	4.57	0.071	0.0125	
0.135	888	4.25	0.060	0.0117	
0.13	818	4.09	0.053	0.0112	
0.115	660	3.62	0.038	0.0099	
0.105	535	3.31	0.028	0.0091	
0.095	396	2.99	0.019	0.0082	
0.075	236	2.36	0.009	0.0065	
0.07	180	2.21	0.006	0.0061	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing   C

R. P. M. of Shaft   1600

Table No.   10

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500		0.012	
1350	0.415	0.01	
1200	0.336	0.0088	
1050	0.29	0.0092	
900	0.29	0.0105	
750	0.285	0.0125	
600	0.245	0.0135	
450	0.225	0.016	
300	0.25	0.0195	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ C _____

R. P. M. of Shaft____ 1200 _____

Table No. 11 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.32	0.0092	
1350	0.26	0.008	
1200	0.21	0.0075	
1050	0.182	0.007	
900	0.162	0.0076	
750	0.16	0.009	
600	0.142	0.0098	
450	0.128	0.0126	
300	0.115	0.017	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ C

R. P. M. of Shaft _____ 1000

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.23	0.008	
1350	0.195	0.007	
1200	0.155	0.007	
1050	0.137	0.006	
900	0.12	0.0066	
750	0.12	0.0077	
600	0.10	0.0084	
450	0.11	0.009	
300	0.135	0.008	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ C

R. P. M. of Shaft_____ 800

Table No.   13

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.16	0.007	
1350	0.14	0.0065	
1200	0.11	0.0063	
1050	0.10	0.0065	
900	0.077	0.0066	
750	0.076	0.0065	
600	0.071	0.0067	
450	0.095	0.006	
300	0.105	0.0053	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ C _____ __ _____

R. P. M. of Shaft _____ 600 ____ _____

Table No. 14 ___ ___ _____ _____ _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.105	0.006	
1350	0.1	0.0061	
1200	0.075	0.0057	
1050	0.065	0.0051	
900	0.047	0.0052	
750	0.047	0.006	
600	0.04	0.0061	
450	0.035	0.0078	
300	0.03	0.0085	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ C _____

R. P. M. of Shaft _____ 400 _____

Table No. 15 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.068	0.006	
1350	0.065	0.006	
1200	0.047	0.0053	
1050	0.04	0.005	
900	0.027	0.0049	
750	0.027	0.0055	
600	0.020	0.0055	
450	0.017	0.006	
300	0.013	0.0065	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ C

R. P. M. of Shaft _____ 200

Table No. 16

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.041	0.006	
1350	0.038	0.0064	
1200	0.028	0.205	
1050	0.022	0.0051	
900	0.020	0.005	
750	0.020	0.0053	
600	0.010	0.005	
450	0.008	0.0045	
300	0.005	0.0056	

Remarks:—

CURVES PLOTTED FROM

TABLES 1 - 16

OF

BEARING "C"

120

BEARING "D"

Fig. 11

Fig. 12

Fig. 13

BEARING "D"

Bearing "D", (Figures 11,12,13), is a
self aligning adapter type radial ball bearing.
The bearing consists of an outer ball race,
an inner ball race, two rows of balls, a
retainer for properly spacing and retaining
the balls between the raceways and a housing
for the whole.

The inner race contains two grooves,
each ground to a radius slightly larger than
the radius of the balls, while the outer
race is ground in the form of a hollow sphere,
whose center is the center of the axis of
rotation. The balls, the retainer and
inner race are free to rotate at any angle
within the outer race and will adjust them-
selves to any possible degree of deflection
of the shaft without binding either the
balls or raceways.

The balls roll on the surface of the
spherically ground outer ball race with a
pure rolling motion without sliding friction.

This action is facilitated by the distri-
bution of the load over a large number of
balls.

These bearings were found to be highly
efficient both in coefficient of friction
and horse power to drive, and the reasons
for this are plentiful. The friction in a
ball bearing is independent of the viscosity
of the lubricant or its temperature; the
frictional resistance of starting and
slow motion is very low. Another advantage
it has is that it is more compact.

This type of bearing permits of the
use of more balls per bearing, because, the
two rows of balls are held in staggered
relation by the retainer. This increases
the carrying capacity of the bearing. The
retainer is made of one piece and it is open
at the sides permitting easy cleaning and
positive lubrication.

The bearings were found to run absolutely
cool at any load and speed and very economical,
but, upon taking the bearings apart after the

test, it was seen that the ball races had
become slightly grooved because of the load.
This immediately decreases the efficiency
of the bearing, because, there then is an
area of contact instead of a point contact.

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TABLES 1 - 16

of

BEARING "D"

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BEARING D

Table No. _____1_____ Date July 14th,1915.

Bearing Load, LBS. _____1500_____ Time, beginning of run 9:25 A.M.

Room Temp.° Fahr. _____74_____ Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31⅛ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.145	2023	4.57	0.147	0.00249	0.00148
0.125	1832	3.94	0.114	0.00215	0.00129
0.11	1546	3.46	0.085	0.00189	0.00113
0.105	1354	3.31	0.071	0.00181	0.00108
0.09	1114	2.84	0.050	0.00155	0.00092
0.085	872	2.67	0.037	0.00146	0.00087
0.085	817	2.67	0.035	0.00146	0.00087
0.08	636	2.52	0.025	0.00138	0.00082
0.07	496	2.20	0.017	0.00121	0.00072
0.065	284	2.05	0.0092	0.00112	0.00067
0.06	130	1.89	0.0039	0.00103	0.00061

Remarks:—

BEARING D

Table No. _____ 2 _____ Date July 14th, 1915.

Bearing Load, LBS. ____ 1350 _____ Time, beginning of run_____

Room Temp.° Fahr. ____ 74 _____ Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	COEFFICIENT OF FRICTION Bearing
0.115	2120	3.62	0.122	0.00221	0.00132
0.10	2003	3.15	0.100	0.00192	0.00114
0.09	1784	2.84	0.080	0.00173	0.00103
0.085	1570	2.67	0.0667	0.00163	0.00097
0.085	1218	2.67	0.0517	0.00163	0.00097
0.085	1115	2.67	0.0473	0.00163	0.00097
0.08	057	2.52	0.0382	0.00154	0.00083
0.075	857	2.36	0.0321	0.00144	0.00086
0.07	730	2.20	0.0255	0.00134	0.00080
0.065	591	2.05	0.0192	0.00125	0.00075
0.06	431	1.88	0.0129	0.00115	0.00069
0.055	316	1.73	0.0087	0.00105	0.00063
0.05	205	1.57	0.0051	0.00096	0.00057

Remarks:— Collar friction eased up at beginning

of run.

BEARING D

Table No. ___3___   Date _July 14th, 1915._

Bearing Load, LBS. ___1200___   Time, beginning of run _10:03 A.M._

Room Temp.° Fahr. ___74___   Time, end of run _10:21 A.M._

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.095	2205	2.99	0.1045	0.00205	0.00122
0.085	1963	2.67	0.0835	0.00183	0.00109
0.08	1753	2.52	0.0702	0.00173	0.00103
0.08	1477	2.52	0.0590	0.00173	0.00103
0.075	1380	2.30	0.0518	0.00162	0.00097
0.075	1127	2.39	0.0422	0.00162	0.00097
0.07	975	2.20	0.0342	0.00151	0.00090
0.065	882	2.05	0.0286	0.00141	0.00084
0.06	831	1.89	0.0249	0.00129	0.00077
0.055	659	1.73	0.0181	0.00119	0.00071
0.055	498	1.73	0.0137	0.00119	0.00071
0.05	329	1.57	0.0082	0.00108	0.00064
0.04	125	1.26	0.0025	0.00086	0.00051

Remarks:—

BEARING D

Table No. _____4_____ Date July 14th, 1915.

Bearing Load, LBS. _____1050_____ Time, beginning of run 10:21 A.M.

Room Temp.° Fahr. _____74_____ Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

| POUNDS at 31¼ in. radius | R. P. M. | TORQUE Inch   Lbs. | Horse Power to Drive | COEFFICIENT OF FRICTION | |
				Shaft	Bearing
0.095	2260	2.99	0.1073	0.00234	0.00139
0.09	2034	2.83	0.0915	0.00221	0.00131
0.085	1768	2.67	0.0952	0.00209	0.00125
0.075	1572	2.36	0.0590	0.00184	0.00110
0.07	1385	2.20	0.0485	0.00172	0.00102
0.07	1125	2.20	0.0395	0.00172	0.00102
0.07	974	2.20	0.0341	0.00172	0.00102
0.065	869	2.05	0.0282	0.00160	0.00095
0.06	747	1.89	0.0224	0.00148	0.00088
0.055	590	1.73	0.0162	0.00136	0.00081
0.045	342	1.42	0.0077	0.00111	0.00066
0.035	146	1.10	0.0026	0.00086	0.00051

Remarks:—

BEARING D

Table No. _____ 5 _____ Date _July 14th, 1915._

Bearing Load, LBS. _____ 900 _____ Time, beginning of run_____

Room Temp.° Fahr. _____ 74 _____ Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.09	2272	2.84	0.1022	0.00259	0.00155
0.085	1994	2.67	0.0847	0.00244	0.00146
0.08	1722	2.52	0.0690	0.00230	0.00137
0.07	1505	2.20	0.0537	0.00205	0.00122
0.065	1272	2.05	0.0414	0.00187	0.00111
0.065	1158	2.05	0.0377	0.00187	0.00111
0.065	964	2.05	0.0314	0.00187	0.00111
0.065	902	2.05	0.0292	0.00187	0.00111
0.055	804	1.73	0.0221	0.00158	0.00094
0.045	618	1.42	0.0139	0.00130	0.00078
0.035	328	1.10	0.0058	0.00100	0.00060
0.03	125	0.95	0.0019	0.00087	0.00057

Remarks:—

BEARING D

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.085	2307	2.67	0.0981	0.00292	0.00174
0.075	2053	2.36	0.0770	0.00258	0.00154
0.065	1761	2.05	0.0573	0.00224	0.00134
0.06	1601	1.89	0.0483	0.00207	0.00124
0.055	1274	1.73	0.0350	0.00189	0.00113
0.055	1157	1.73	0.0318	0.00189	0.00113
0.055	983	1.73	0.0270	0.00189	0.00113
0.05	876	1.58	0.0219	0.00173	0.00103
0.045	788	1.42	0.0178	0.00156	0.00093
0.04	616	1.26	0.0123	0.00138	0.00082
0.35	445	1.10	0.0078	0.00120	0.00072
0.025	210	0.79	0.0026	0.00087	0.00057

Remarks:—

BEARING D

Table No. _____7_____ Date __July 14th, 1915.__

Bearing Load, LBS. ___600___ Time, beginning of run 11:04 A.M.

Room Temp.° Fahr. ___74___ Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.08	2310	2.52	0.0925	0.00345	0.00206
0.07	2012	2.21	0.0705	0.00303	0.00187
0.06	1731	1.89	0.0519	0.00259	0.00155
0.055	1451	1.73	0.0400	0.00237	0.00141
0.05	1255	1.58	0.0314	0.00216	0.00129
0.05	1170	1.58	0.0293	0.00216	0.00129
0.05	1004	1.58	0.0251	0.00216	0.00129
0.045	936	1.42	0.0211	0.00194	0.00116
0.045	822	1.42	0.0185	0.00194	0.00116
0.04	700	1.26	0.0140	0.00172	0.00103
0.03	513	0.95	0.0077	0.00129	0.00077
0.03	350	0.95	0.0053	0.00129	0.00077
0.0225	150	0.71	0.0017	0.00097	0.00058

Remarks:—

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BEARING D

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.075	2293	2.36	0.0860	0.00432	0.00251
0.065	2034	2.05	0.0661	0.00375	0.00223
0.055	1689	1.73	0.0464	0.00316	0.00188
0.05	1554	1.58	0.0388	0.00289	0.00172
0.05	1403	1.58	0.0351	0.00289	0.00172
0.045	1160	1.42	0.0261	0.00259	0.00154
0.045	986	1.42	0.0222	0.00259	0.00154
0.04	900	1.26	0.0180	0.00230	0.00137
0.04	837	1.26	0.0167	0.00230	0.00137
0.035	704	1.10	0.0123	0.00201	0.00120
0.025	333	0.79	0.0042	0.00141	0.00086
0.02	130	0.63	0.0013	0.00115	0.00069

Remarks:—

BEARING D

Table No. _____ 9 _____ Date __July 14th, 1915.__

Bearing Load, LBS. _____ 300 _____ Time, beginning of run _____

Room Temp.° Fahr. _____ 74 _____ Time, end of run __12:00 M.__

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.075	2400	2.36	0.0900	0.00647	0.00386
0.065	2184	2.05	0.0712	0.00563	0.00336
0.06	1924	1.89	0.0578	0.00519	0.00309
0.055	1687	1.73	0.0464	0.00475	0.00283
0.05	1594	1.58	0.0398	0.00433	0.00258
0.045	1264	1.42	0.0285	0.00390	0.00232
0.045	1117	1.42	0.0252	0.00390	0.00232
0.05	985	1.58	0.0246	0.00433	0.00258
0.055	876	1.73	0.0242	0.00475	0.00283
0.055	679	1.73	0.0187	0.00475	0.00283
0.05	483	1.58	0.0121	0.00433	0.00258
0.045	290	1.42	0.0065	0.00390	0.00232
0.04	151	1.26	0.0031	0.00346	0.00206
0.02	88	0.63	0.0009	0.00173	0.00103

Remarks:—   Excessive collar friction during run.

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ D _____

R. P. M. of Shaft_____ 2000 _____

Table No.__ 10 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.145	0.0024	0.00155
1350	0.104	0.0022	0.0013
1200	0.092	0.0019	0.0011
1050	0.091	0.0023	0.0014
900	0.08	0.0025	0.0015
750	0.07	0.0025	0.0015
600	0.068	0.003	0.0017
450	0.06	0.0036	0.0025
300	0.06	0.0051	0.0033

Remarks:—

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DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ D _____

R. P. M. of Shaft_____ 1600 _____

Table No. 11 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.087	0.002	0.0012
1350	0.065	0.002	0.001
1200	0.065	0.0017	0.0009
1050	0.067	0.002	0.0012
900	0.051	0.002	0.0012
750	0.048	0.0021	0.0012
600	0.042	0.0025	0.0013
450	0.042	0.0028	0.0017
300	0.043	0.0041	0.0026

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ D

R. P. M. of Shaft_____ 1200

Table No._ 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.056	0.0017	0.001
1350	0.043	0.0015	0.0009
1200	0.04	0.0015	0.0007
1050	0.044	0.0017	0.0009
900	0.031	0.0018	0.001
750	0.032	0.002	0.001
600	0.028	0.0022	0.0011
450	0.028	0.0024	0.0014
300	0.031	0.0038	0.0024

Remarks:—

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DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ D

R. P. M. of Shaft _____ 800

Table No. 13

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.035	0.0014	0.0007
1350	0.026	0.0013	0.0005
1200	0.02	0.0012	0.0005
1050	0.024	0.0015	0.0006
900	0.02	0.0015	0.0006
750	0.02	0.0019	0.0009
600	0.015	0.002	0.0009
450	0.016	0.002	0.0011
300	0.021	0.0047	0.0021

Remarks:—

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DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ D _____

R. P. M. of Shaft _____ 600 _____

Table No. 14 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.024	0.0012	0.0005
1350	0.018	0.0011	0.0004
1200	0.012	0.001	0.0004
1050	0.015	0.0013	0.0005
900	0.015	0.0014	0.0005
750	0.015	0.0016	0.0008
600	0.011	0.0018	0.0008
450	0.01	0.0019	0.0010
300	0.017	0.005	0.0032

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ D _____

R. P. M. of Shaft _____ 400 _____

Table No. 15 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.014	0.001	0.0005
1350	0.011	0.001	0.0003
1200	0.007	0.001	0.0003
1050	0.008	0.0011	0.0004
900	0.01	0.001	0.0004
750	0.008	0.0015	0.0006
600	0.005	0.0015	0.0004
450	0.006	0.0016	0.0010
300	0.012	0.0045	0.0028

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ D

R. P. M. of Shaft _____ 200

Table No. 16

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.007	0.001	0.0004
1350	0.004	0.001	0.0003
1200	0.004	0.001	0.0003
1050	0.004	0.001	0.0003
900	0.004	0.001	0.0003
750	0.003	0.0009	0.0002
600	0.003	0.0009	0.0002
450	0.002	0.0013	0.0008
300	0.007	0.003	0.002

Remarks:—

- -

CURVES PLOTTED FROM

TABLES 1 - 16

OF

BEARING "D"

- -

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BEARING "E"

Fig. 14

Fig. 15

BEARING"E"

Bearing "E", (Figures 14,15), is a
roller bearing with a single roller structure,
with all parts split so as to be able to apply
the bearing to the shaft easily.

A split bushing or sleeve fits over the
shaft and this is the raceway for the rolls.
Two collars which clamp the split bushing to
the shaft retain the roller structure, afford-
ing movable surfaces with which the ends of
the roller structure come into contact. The
collars do not touch the box, thereby, reliev-
ing the bearing from end thrust.

The rolls are held by a steel retainer
and each retainer is split. A ground portion
of the inside of the bearing box provides
an outer raceway for the rolls. The grease
is retained in the box by pieces of felt which
fit into grooves in the ends of the bearing
box.

The chief fault of this bearing is
that when mounting the split bushing on the

shaft, it would never fit exactly around
the circumference and consequently did not
provide a perfectly cylindrical raceway
for the rolls. The result of this, is,
that there is a pounding up and down of
the split retainer and an inability of the
rolls to take their proper load. This
caused a heating of the bearing and a
comparatively high coefficient of friction.

During all runs, the felt oil retainers
were removed as they were so tight against
the shaft that they caused the bearing and
shaft to heat up to a greater extent than
was allowable, but, this fault could be
easily overcome by the use of a better grade
of felt and having a looser fit on the shaft.

While running under load, the bearing
was quite noisy and prone to heat up to an
alarming extent.

- -

TABLES 1 - 13

OF

BEARING "E"

- -

BEARING E

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.82	526	25.05	0.215	0.0137	0.01048
0.76	512	23.90	0.195	0.0131	0.0100
0.73	488	23.00	0.178	0.0126	0.00962
0.67	476	21.10	0.159	0.0116	0.00886
0.645	429	20.30	0.138	0.0111	0.00848
0.61	310	19.20	0.095	0.0105	0.00802
0.58	228	18.25	0.066	0.0100	0.00763

Remarks:— Considerable vibration noted during run.

BEARING E

Table No. _____2_____   Date __July 21st, 1915.__

Bearing Load, LBS. __1350__   Time, beginning of run_____

Room Temp.° Fahr. __73__   Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.73	564	23.30	0.208	0.0142	0.01083
0.68	551	21.40	0.188	0.0131	0.0100
0.67	528	21.10	0.177	0.0128	0.00977
0.57	469	17.95	0.132	0.0109	0.00832
0.495	442	15.60	0.110	0.0095	0.00725
0.48	319	15.10	0.077	0.0092	0.00703
0.47	237	14.80	0.056	0.0090	0.00688

Remarks:—

B E A R I N G   E

Table No._____3_____   Date__July 21st, 1915.__

Bearing Load, LBS.____1200____   Time, beginning of run_____

Room Temp.° Fahr.____73____   Time, end of run__9:33 A.M.__

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¾ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.69	618	21.70	0.213	0.0148	0.01130
0.575	602	18.10	0.173	0.0124	0.00947
0.48	536	15.10	0.129	0.0104	0.00794
0.445	433	14.00	0.096	0.0096	0.00733
0.425	401	13.40	0.085	0.0092	0.00703
0.42	364	13.21	0.077	0.0091	0.00695
0.43	284	13.52	0.061	0.0093	0.00710
0.445	258	14.00	0.058	0.0096	0.00733
0.46	200	14.48	0.046	0.0099	0.00755

Remarks:—

BEARING E

Table No._____4_____   Date___July 21st, 1915.___

Bearing Load, LBS.____1050_____   Time, beginning of run__9:35 A.M.

Room Temp.° Fahr.___73_____   Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

| POUNDS at 31¼ in. radius | R. P. M. | TORQUE Inch   Lbs. | Horse Power to Drive | COEFFICIENT OF FRICTION | |
				Shaft	Bearing
0.56	626	17.62	0.175	0.0138	0.01053
0.49	607	15.42	0.149	0.0121	0.00925
0.43	570	13.53	0.123	0.0106	0.00809
0.415	461	13.08	0.096	0.0102	0.00779
0.39	425	12.28	0.083	0.0096	0.00733
0.36	383	11.34	0.069	0.0089	0.00679
0.375	316	11.80	0.059	0.0092	0.00703
0.37	311	11.64	0.057	0.0091	0.00695
0.385	258	12.12	0.050	0.0095	0.00725
0.405	180	12.73	0.036	0.0100	0.00754

Remarks:—

BEARING E

Table No._____5_____ Date__July 21st,1915.____

Bearing Load, LBS.____900_____ Time, beginning of run_____

Room Temp.° Fahr.____73_____ Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.345	627	10.86	0.108	0.0099	0.00756
0.33	542	10.38	0.090	0.0095	0.00725
0.31	502	9.77	0.078	0.0089	0.00679
0.305	424	9.60	0.065	0.0086	0.00657
0.31	414	9.77	0.064	0.0089	0.00679
0.315	331	9.92	0.052	0.0091	0.00695
0.32	297	10.08	0.048	0.0092	0.00903
0.34	210	10.38	0.035	0.0095	0.00725

Remarks:—

BEARING E

Table No._____ 6 _____ Date__July 21st, 1915.____

Bearing Load, LBS.____750____ Time, beginning of run__10 A.M.

Room Temp.° Fahr.____73____ Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.315	670	9.92	0.106	0.0109	0.00833
0.295	621	9.28	0.092	0.0102	0.00778
0.275	538	8.67	0.094	0.0095	0.00725
0.27	495	8.50	0.067	0.0093	0.00710
0.26	385	8/18	0.050	0.0090	0.00687
0.265	365	8.34	0.048	0.0091	0.00695
0.27	304	8.50	0.041	0.0093	0.00710
0.275	288	8.66	0.040	0.0095	0.00625
0.28	212	8.82	0.030	0.0097	0.00741

Remarks:—

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BEARING E

Table No. ____7____   Date____July 21st, 1915.____

Bearing Load, LBS.____600____   Time, beginning of run_____

Room Temp.° Fahr.____73____   Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.265	645	8.34	0.086	0.0114	0.0087
0.26	596	8.18	0.078	0.0112	0.0086
0.24	525	7.57	0.063	0.0103	0.00786
0.23	441	7.25	0.051	0.0099	0.00756
0.22	388	6.94	0.043	0.0095	0.00725
0.21	292	6.63	0.031	0.0091	0.00695
0.215	266	6.78	0.029	0.0093	0.00710
0.23	177	7.25	0.020	0.0099	0.00756

Remarks:—

BEARING E

Table No. _____ 8 _____ Date _July 21st, 1915._

Bearing Load, LBS. _____ 450 _____ Time, beginning of run _____

Room Temp.° Fahr. _____ 73 _____ Time, end of run _____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.215	659	6.78	0.071	0.0124	0.00946
0.205	558	6.48	0.057	0.0118	0.00901
0.195	476	6.15	0.046	0.0113	0.00862
0.19	445	5.99	0.042	0.0109	0.00832
0.18	365	5.68	0.033	0.0104	0.00794
0.17	320	5.36	0.027	0.0098	0.00748
0.16	260	5.04	0.021	0.0092	0.00703
0.17	189	5.36	0.016	0.0098	0.00748
0.175	149	5.52	0.013	0.0101	0.00771

Remarks:—

BEARING E

Table No._____9_____ Date__July 21st, 1915.____

Bearing Load, LBS._____300_____ Time, beginning of run_____

Room Temp.° Fahr._____73_____ Time, end of run_____

Observers _____

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.20	671	6.31	0.067	0.0173	0.01320
0.19	632	5.98	0.060	0.0164	0.01251
0.18	591	5.68	0.053	0.0155	0.01182
0.165	529	5.20	0.044	0.0142	0.01083
0.155	411	4.88	0.032	0.0134	0.01023
0.145	377	4.57	0.027	0.0125	0.00953
0.14	318	4.42	0.022	0.0121	0.00923
0.13	247	4.10	0.016	0.0112	0.00855
0.13	202	4.10	0.013	0.0112	0.00855
0.14	128	4.26	0.009	0.0117	0.00893
0.145	66	4.41	0.005	0.0121	0.00923

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ E

R. P. M. of Shaft ___600

Table No.__ 10

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500		0.016	0.014
1350	0.245	0.016	0.014
1200	0.2	0.014	0.0105
1050	0.14	0.0125	0.0096
900	0.10	0.0095	0.0075
750	0.09	0.0101	0.008
600	0.077	0.0103	0.0082
450	0.057	0.0157	0.012
300	0.063	0.0137	0.0092

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ E _____

R. P. M. of Shaft ___ 400 _____

Table No. 11

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.12	0.0107	0.008
1350	0.105	0.0098	0.0075
1200	0.088	0.0095	0.0072
1050	0.075	0.0092	0.0070
900	0.058	0.0088	0.0068
750	0.052	0.0095	0.0072
600	0.05	0.0095	0.0077
450	0.03	0.0127	0.0096
300	0.04	0.0105	0.008

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ E

R. P. M. of Shaft ___ 200

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.06	0.01	0.0079
1350	0.05	0.009	0.007
1200	0.045	0.0095	0.0075
1050	0.04	0.0097	0.0075
900	0.033	0.0095	0.0075
750	0.03	0.0098	0.0075
600	0.025	0.0097	0.008
450	0.01	0.0115	0.0088
300	0.016	0.0098	0.0074

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing _____ E _____

R. P. M. of Shaft ____ 100 _____

Table No. 13 _____

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.046	0.0105	0.0085
1350	0.036	0.0095	0.0076
1200	0.035	0.0106	0.0089
1050	0.023	0.011	0.0085
900	0.026	0.011	0.0089
750	0.025	0.0105	0.0082
600	0.01	0.0102	0.0085
450	0.005	0.012	0.009
300	0.007	0.0097	0.0073

Remarks:—

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CURVES PLOTTED FROM

TABLES 1 - 13

OF

BEARING "E"

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MAXIMUM   AND   MINIMUM

CURVES FOR

ALL   BEARINGS
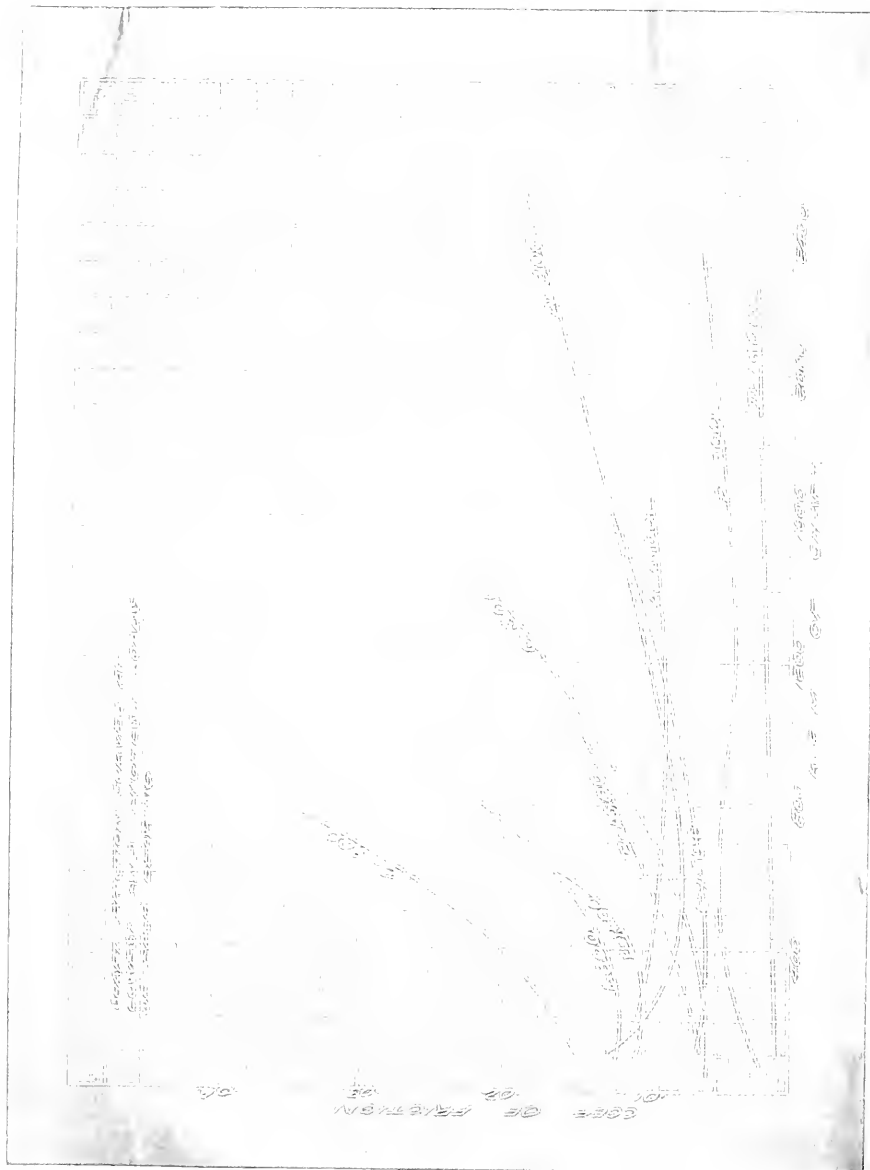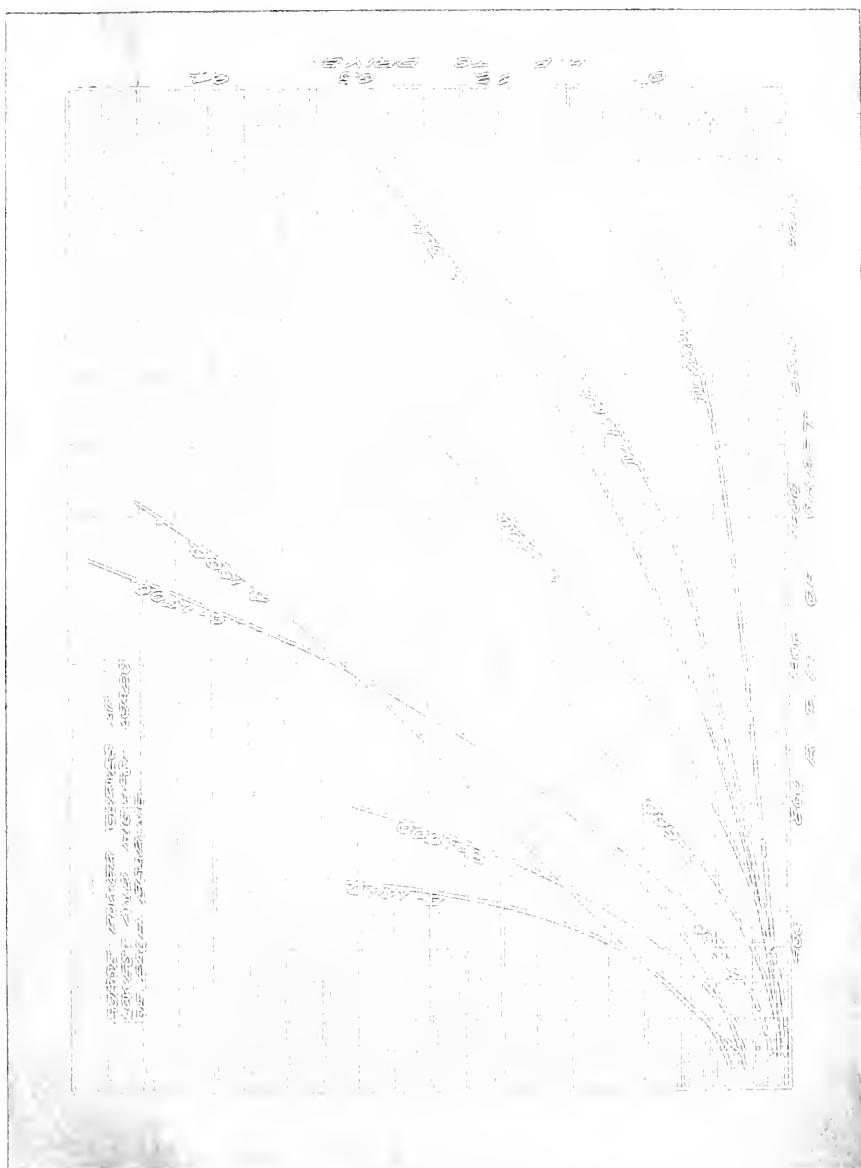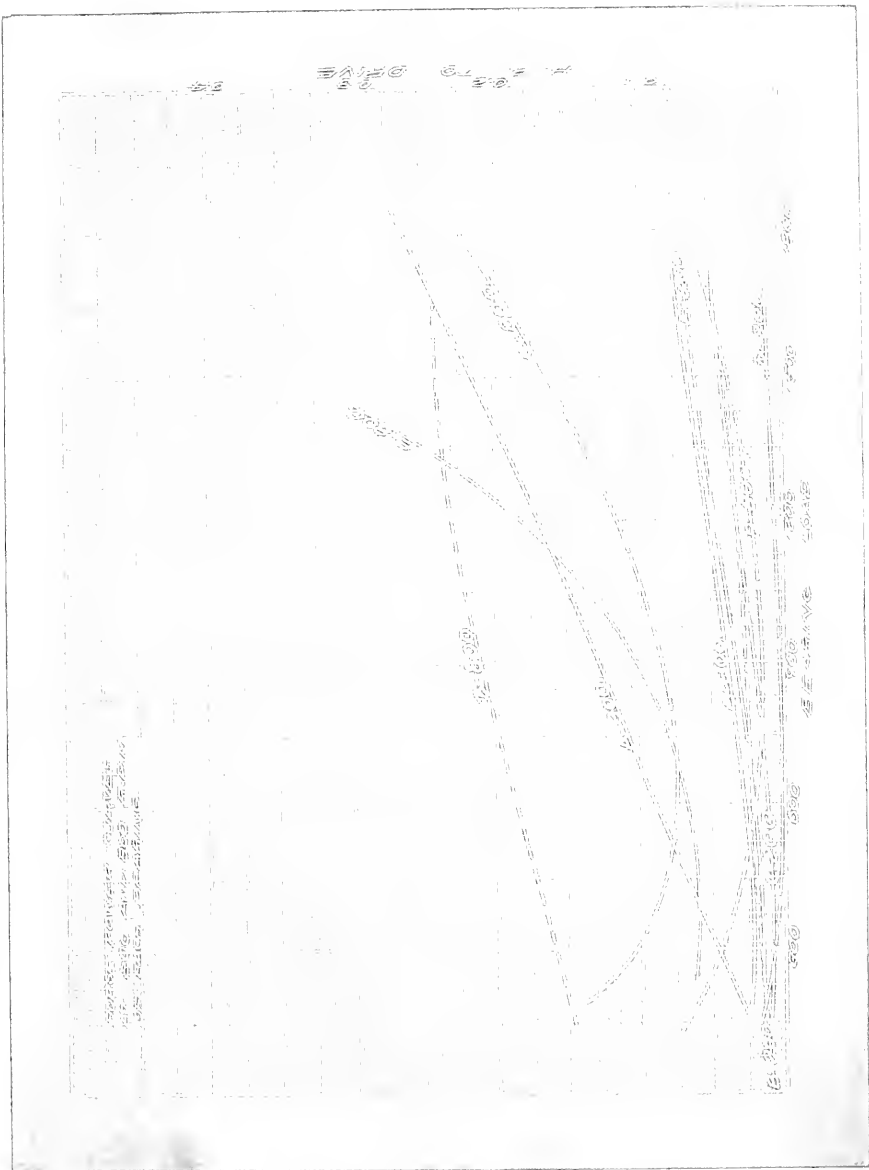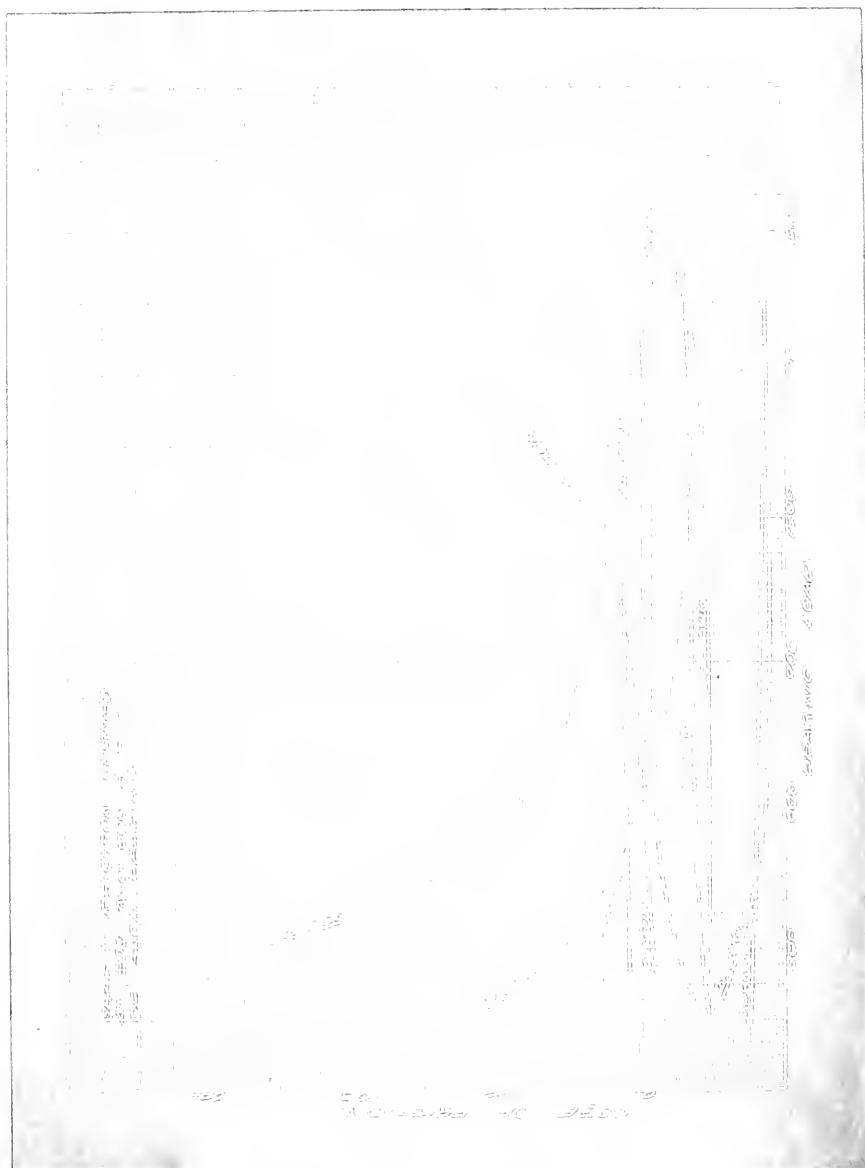
DISCUSSION OF RESULTS

DISCUSSION OF RESULTS

The first set of curves, plotted from
tables 1 to 9, are those whose values are
taken directly from the results of the
test. Each sheet shows the curves for
coefficients of friction and horse power
to drive as compared to the speed of the
shaft at some particular load.

The second set of curves, tables 10
to 16, were interpolated from the first set.
The speed on each sheet being constant and
the points plotted against a varying bearing
load.

The third set is a résumé of the first
set showing the maximum and minimum curves
of the first set for each bearing.

The fourth set is a résumé of the second
set, showing maximum and minimum curves
for each bearing.

In all cases each curve is plainly
marked with the bearing initial.

It will be seen from the sheet showing
the maximum and minimum curves for each

Bearing plotted against the speed of the
shaft that in every case, the coefficient
of friction decreases as the load increases
and that the coefficient of friction increases
as the speed increases.

This sheet shows that Bearing "D", the
ball bearing has the lower coefficient of
friction at any load and speed than any
other bearing. It further shows that the
coefficient does not vary much with differences
in load, and that it varies very little with
any increase in speed, thus, giving to it all
the desirable features of a shating bearing.

Bearing "C", the babbitt bearing showed
itself to be next best at the low speeds, but,
as soon as the speeds increased beyond five
or six hundred R.P.M., Bearing "A", the
duplex roller bearing showed itself to be
better. Bearing "A" was very nearly as good
as the babbitt at low speeds and very much better
at high speeds, it being the only bearing which
we could run at much more than 2000 R.P.M.
It showed itself to be similar to the ball
bearing because its curve was flat at all

loads and speeds. So for this reason, we
should say that it was the second best bearing
we tested.

At the low loads and low speeds, Bearing "B",
the spiral roller bearing, showed itself to
be the poorest of all, and at high speeds it
had a tendency to increase its coefficient of
friction to infinity.

Bearing "E", the third roller bearing
was fairly good at low speeds, but, poor at
high speeds. It did not vary to any great
extent for the difference in load, but, as
a whole the coefficient of friction was far
too high.

Bearing "D" also showed its superiority
by virtue of the fact that it took less power
to drive it at any speed and load than any
other bearing.

Bearings "A", "B", "C" and "E" showed
themselves to take about the same power to
drive at low speeds, although, Bearing "A"
may be given the preference since it requires
less power at the low speeds than the others.

At the high speeds and high loads, Bearing "A" also showed up well, although, very little better than the babbitt.

Bearing "B" and "E" showed up well on the low speeds only, but, an increased speed caused their friction to increase rapidly.

All the curves showed that the horse power necessary to drive increased with the load and increased with the speed.

Arthur Kalgunger

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